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I. Invited Speakers

Nitrate and Selected Pesticides in Ground Water of the Mid-Atlantic Region

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Data collected from more than 850 sites between October, 1985 and September, 1996 (inclusive) were compiled and analyzed to document the occurrence of nitrate and pesticides in ground water of the Mid-Atlantic region. Nitrate was detected in nearly three-quarters of the samples for which it was analyzed, commonly at levels that suggest anthropogenic sources. Ten percent of samples contained nitrate at concentrations exceeding the Federal Maximum Contaminant Level (MCL) of 10 milligrams per liter as nitrogen. Pesticide compounds (including atrazine, metolachlor, prometon, simazine, and desethylatrazine, an atrazine degradate) were detected in about half of the samples for which they were analyzed, but rarely at concentrations exceeding established MCL's. The most commonly detected pesticide compounds were desethylatrazine and atrazine.

The occurrence of nitrate and pesticides in ground water of the Mid-Atlantic region is related to land cover and rock type. Likely sources of nitrate and pesticides to ground water include agricultural and urban land-use practices; rock type affects the movement of these compounds into and through the ground-water system. Nitrate concentrations in the compiled data set are significantly higher in ground water in agricultural areas than in urban or forested areas. Detection frequencies of atrazine, desethylatrazine, and simazine are indistinguishable among urban areas, row crops, and pastures. Prometon was most commonly detected in ground water in urban areas. Concentrations of nitrate and detection frequencies of pesticides were significantly higher in samples from carbonate rocks than in those from any other rock type.

Pesticides in Surface Waters in the Mid-Atlantic Integrated Assessment Region

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Data for more than 2500 samples from 463 sites were compiled and analyzed to document the occurrence and distribution of pesticides in surface waters of the Mid-Atlantic region as part of the Mid-Atlantic Integrated Assessment program of the U.S. Environmental Protection Agency. Only those data collected by the U.S. Geological Survey between October, 1973 and December, 1996 (inclusive) were used in the analysis. Most of the available data were collected since 1992, and more samples were collected during the months of the growing season, April through September, than during other months. Data are available for most of the Mid-Atlantic region, but large spatial gaps in available data do exist.

Data are available for 127 compounds, including 12 degradates; but only 16 compounds were detected in more than 100 samples. Atrazine and metolachlor were the most frequently detected compounds, in more than 70 percent of samples. Concentrations of atrazine exceeded the Federal Maximum Contaminant Level (MCL) for drinking water of 3 *u*g/L (micrograms per liter) in 67 of 2077 samples from 15 sites. MCL's for alachlor (2 *u*g/L) and simazine (4 *u*g/L) were exceeded in 13 and 18 samples, respectively.

Data from the 32 most frequently sampled sites were used to determine seasonal patterns and temporal variability. Pesticide occurrences in these surface-water sites were also related to land use in the contributing watersheds. Median concentrations of several compounds, such as diazinon and chlorpyrifos, were found to be highest in watersheds with a significant percentage of urban land.

The Bird Community Index: A Tool for Assessing Biotic Integrity in the Mid-Atlantic Highlands

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As part of the U.S. Environmental Protection Agency's (EPA's) Environmental Monitoring and Assessment Program (EMAP), we developed an indicator of biotic integrity based on songbird community composition. Because songbirds occur in a wide variety of habitat types, the bird community index (BCI) is intended to integrate ecological conditions across a large physiographic region exhibiting diverse land-cover attributes and intensities of human use. Comprised of multiple biological metrics, our indicator is an index that ranks bird communities according to the proportional representation of 16 behavioral and physiological response guilds. Relative proportions of "specialist" and "generalist" guilds, viewed as indicators of structural, functional, and compositional ecosystem elements, determine condition. We developed the BCI from 34 reference sites in central Pennsylvania that represent a gradient of ecosystem condition from near pristine to severely degraded. Upon satisfactory demonstration that the BCI could discriminate between categories of ecosystem condition, we applied the BCI to independent samples of 126 sites across the Mid-Atlantic Highlands Assessment (MAHA) area. Sites were selected using EMAP's probability-based sampling design, and therefore represent the total land area in the region. To verify the BCI's discriminatory properties, we compared the BCI assessment to independent gradients of landscape disturbance applied to both the 34 reference sites and the 126 MAHA sites. The BCI identified four categories of biotic integrity in the MAHA area. Our assessment indicated that 16% of the area is in "excellent" condition, 27% is "good", 36% is "fair", and 21% is in "poor" condition. Urban and agricultural sites differ in their respective guild compositions, but are not separable by overall BCI score. Forested sites supporting the two highest-integrity categories contain different site-level vegetation attributes, but cannot be separated by landscape-level land-cover composition. This research also defined thresholds of land-cover change where significant shifts in BCI categories were observed.

Integrated Estuarine Monitoring in the Mid-Atlantic

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There is currently no comprehensive scientific basis to assess the ability of the natural environment to continue to meet human needs. The Committee on the Environment and Natural Resources highlighted the need for a national framework to integrate ongoing environmental monitoring programs in a cost efficient way to produce comparable data to improve both environmental policy and scientific understanding. In 1997 and 1998, the Mid-Atlantic Integrated Assessment (MAIA) program began a coordinated monitoring effort of the mid-Atlantic estuaries to demonstrate that effective partnerships could be established among Federal and State agencies with estuarine responsibilities. This coordinated effort was intended to fill data gaps in characterizing the ecological condition of the MAIA estuaries and determine better monitoring approaches for small systems. Monitoring was based on two principles: agreement on a common set of measures, and integration of the partners' existing sampling stations. In 1997, approximately 900 stations were sampled by the partners, with primary emphasis on water and sediment quality. In 1998, approximately 700 stations were sampled by the partners for water quality parameters. In addition, a subset of the stations sampled in 1997 were revisited by EPA's Atlantic Ecology Division and sampled for contaminants in fish. This effort showed that integration of existing sampling programs can be successful, but requires substantial commitment and commitment and communication among participants. Further work is needed to institutionalize consistent sampling methods and expand the partners' monitoring programs to include contaminants in fish.

Geographic Analyses of Species Richness and Community Attributes of Forest Birds from Survey Data in the Mid-Atlantic Integrated Assessment (MAIA) Region

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As part of an assessment of the condition of forests in the Mid-Atlantic Integrated Assessment (MAIA) Region, we have been using data from the North American Breeding Bird Survey (BBS) to estimate spatial and temporal change in community attributes of forest-breeding birds. Although bird survey data are limited because species are missed during counting, recently-developed methods for estimation of community attributes such as species richness can be used to provide unbiased estimates of spatial and temporal patterns of extinction, colonization, and biotic integrity of species. We describe these methods, their application to bird data from the MAIA region, and present some preliminary data on the association of bird community attributes with remotely-sensed habitat data.

Estimates have been made for each BBS route in five states: Delaware, Maryland, Pennsylvania, Virginia, West-Virginia. We focused on two groups of birds: forest birds, and area-sensitive forest birds. "Area-sensitivity" was used as a criterion to characterize "interior-forest" birds. Depending on the data available for each BBS route, species richness has been estimated for the largest number of years within the 1975-1990 period (i.e., 16 estimates are available for the routes that have been run each year). Extinction probability and turnover between 1975 and 1990 have been estimated for the species groups on each BBS route in the five states. The Breeding Bird Survey routes have been digitized (the path of each route), and estimates of species richness (forest birds and interior forest birds), estimates of extinction probability, and of species turnover have been mapped for the two groups of species. We have also evaluated the association between bird community integrity and amount of urbanization adjacent to the survey route, and generally document negative associations.

Large Scale Amphibian Monitoring in the Mid-Atlantic: Power to the People

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Both the presence and the absence of amphibian declines in the Mid-Atlantic region are greatly exaggerated. Little is known of the current status or trajectory for most species other than all the species historically known from the region are still present. However, large scale probabilistic surveys for amphibians are being developed for the region to provide the quantitative evidence needed to document population change. Calling surveys for anurans are planned for all states in the Mid-Atlantic, identification materials, identification tests, hearing tests, online data entry, and data access are in preparation. An online bibliography with keyword searches is now available at for references and web sites (http://monitoring2.pwrc.nbs.gov/amphibs/) These surveys will use volunteer observers. Volunteers have the ability to accurately identify species, produce surveys with consistent results (i.e., low CV's), have long tenure on surveys (unlike technicians), and cost nothing.

Pilot data and published counts of amphibians using a large variety of techniques were evaluated for count variation and the impacts of that variation on sample size and replication requirements. The average coefficient of variation for all techniques applicable in the North East is 40% (n=42) and 62% (n=70) in the Southeast. Few natural history or methodological patterns were evident. Variation across years in counts of an individual species can range from very high to very low even within single studies. Most of the highest variation was associated with counts from temporary pool environments that had no or low reproduction in some years. Low variation was associated with a number of species groups with terrestrial and stream side salamander counts averaging lower than others (http://WWW.MP1-PWRC.USGS.GOV/powcase/powcase.html).

The use of presence/absence of amphibians at a site was a great tamer of CV's. CV's varied from 3% to 43% with an average of 20% on calling surveys based on frequency in ecoregions of Wisconsin.

Assessment of Forest Disturbance in the Mid-Atlantic Region: A Multi-Scale Linkage Between Terrestrial and Aquatic Ecosystems

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The objective of this project is to develop, test, validate, and demonstrate an analytical framework for assessing regional-scale forest disturbance in the mid-Atlantic region by establishing a multi-scale linkage between forest disturbance and forest nitrogen export to surface waters. It is hypothesized that excessive nitrogen (N) leakage (export) from forested watersheds is a potentially useful, integrative "indicator" of a negative change in forest function which occurs in synchrony with changes in forest structure and species composition. Our research focuses on forest disturbance associated with recent defoliations by the gypsy moth larva at spatial scales ranging from small watersheds to the entire region. By combining data from intensively-monitored watersheds describing forest N leakage resulting from gypsy moth defoliation with spatially-extensive data describing the distribution of forest species in the mid-Atlantic region, the spatial pattern of gypsy moth disturbances to forested areas, and survey measurements of dissolved N species in surface water, an approach for assessing the magnitude of forest disturbance and its impact on surface water quality will be demonstrated. The project will thus effectively provide a multi-resource linkage between forests and surface waters in the mid-Atlantic region using data and models assembled from (1) watershed-scale studies of intensively-studied systems, (2) synoptic-scale surveys of resource conditions (including soils, forests, surface waters, etc.), and (3) remotely-sensed information.

A major task of the project is the incorporation of disturbance into a useful model of N export from forests to receiving surface waters. It has been shown that N export due to a single disturbance can be empirically described using a linear impulse response function model known as the UNERF (Unit Nitrogen Export Response Function) and that N export from multiple disturbances can thus be described using the convolution integral. Actual N export time series for disturbed, intensively-monitored watersheds have the same general shape, characterized by a rather steep increase in export beginning shortly after the time of disturbance, a peak N export rate occurring 1-2 years after disturbance, and a recession to normal baseline levels over several years following the peak. Though it is believed that the UNERF model parameters likely vary as a function of forest type and by ecoregion, it is possible to make some gross assumptions about these parameters as a means of (1) illustrating the proposed analytical technique and (2) providing a first-order assessment of the importance of forest disturbances (relative to other point and non-point sources) as sources of N to receiving surface waters in the region. Results and uncertainties associated with the current assessment are discussed in the context of addressing this important watershed management issue.

A Hierarchical, Patch Dynamics Approach to the Long Term Study of Urban Ecological Systems: Baltimore, MD

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Recognizing the need for the long term study of basic ecological processes, the National Science Foundation (NSF) established and has maintained a Long Term Ecological Research (LTER) network for nearly twenty years. Increasingly, however, biological ecologists have recognized the need for the explicit study of human ecological systems and of urbanization, which is a dominant type of global change. To address these needs, NSF established recently two urban LTERs in metropolitan regions: one centered around Baltimore, Maryland, the other around Phoenix, Arizona. Critical to these two LTERs is their ability to integrate dynamic physical, biological, and social systems in terms of structure and function; to include hierarchical scales of organization; and to analyze the spatial heterogeneity of these systems. In order to respond to these issues, both sites have adopted an hierarchical, patch dynamics approach even though the two sites are significantly different in terms of their pre-historic, historic, and present physical, biological, and social dynamics. This presentation is separated into two parts. The first part describes the conceptual and analytic basis for integrating physical, biological, and social systems through an hierarchical, patch dynamics approach to human ecological systems. The second part illustrates how this approach is being applied to the long term study and monitoring of the Baltimore metropolitan region.

Keywords*:* human ecology, urban, patch dynamics, Baltimore, Maryland

Perspective on Analysis and Research Integration Through the Baltimore-Washington Regional Collaboratory

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An experiment was initiated by the Spatial Analysis Laboratory of the University of Maryland, Baltimore County, in 1995 to determine the structural feasibility and potential applications for a regional spatial data management network. This spatial network, the Baltimore-Washington Regional Collaboratory, sponsored in part by NASA's office of Earth Science, has supported a series of outreach, education partnerships, and research activities dealing with ecological of regional data and users has been identified and linked to the Collaboratory. Results are pr, social, and physical science issues. A hallmark program of the Collaboratory has been the 200-year land use dynamics study conducted in cooperation with the United States Geological Survey (USGS) HILT program. Direct results of the Collaboratory include the NSF funded Baltimore Ecosystem Study (Long-Term Ecological Research) in cooperation with the United States Forest Service (USFS), USGS, and EPA; and the Urban-Rural Index in cooperation with the Chesapeake Bay office. A complex stratification presented in terms of the Web-based regional structure (systems and data architecture), and performance of the myriad outreach (regional community utilization), and research projects (data integration and synthesis).

URL: www.umbc.edu/bwrdc - Baltimore Washington Regional Collaboratory

baltimore.umbc.edu/lter - LTER

Evaluating Landscape Metrics as Indicators of Forest Ecosystem Health

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Current landscape ecological theory holds that ecosystem structure affects, and may be predictive of, ecosystem function. This suggests that landscape metrics (e.g., percent forest cover, forest fragmentation) can be used to arrange forested ecosystems along a gradient of "ecosystem health." However, correlations between landscape metrics and ecosystem condition and function have not been quantified extensively. The strength of these correlations will determine the utility of landscape metrics as measures of ecosystem health. The USDA Forest Service's Forest Health Monitoring Program has initiated work to quantify the correlations between landscape metrics and other measures of forest ecosystem health, including wildlife species richness, extinction rates, and turnover; and various measures of water quality.

We will present our conceptual model for an integrated landscape-level forest health assessment, illustrated by ongoing work toward quantifying the relationships among several landscape metrics and water quality parameters. Our model is hierarchical and describes a complex, interconnected landscape at multiple scales. Data are synthesized and analyzed at appropriate scales, as indicated by the conceptual model. We will use landscape metrics developed for 8-digit hydrologic units as part of the Mid-Atlantic Integrated Assessment (MAIA) and water quality data (e.g., sedimentation, benthic macroinvertebrate assemblages) collected as part of the Mid-Atlantic Highlands Assessment (MAHA). The MAHA data also include measures of landscape composition for the sample point basin. These data will allow us to evaluate the relationship between landscape composition and water quality at two scales. We will present preliminary results, highlight their implications, and make recommendations for further research.

Characteristics of Maryland Agriculture Relevant for Environmental Assessment

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This project is designed to assemble and present statistical data representing attributes of the Maryland agriculture production system relevant for assessment of the environmental benefits contributed by this critical food and fiber production sector of the economy. Agricultural statistics at the traditional county boundaries were aggregated to the watershed level permitting the first step toward evaluating agricultural production practices have on the environment.

The sources of the data series presented in this publication are primarily the Maryland Agriculture Statistics Service and the National Agricultural Statistics Service. In some cases the format of the data series were reconfigured to more effectively depict the various facets of agriculture and their environmental influence. Examination of the information presented in this publication are intended to provide both the general public and the scientific community with increased understanding of the role of agriculture in the quality of life in the ecosystem of the Mid Atlantic area and the Chesapeake Bay region and to make people more aware of the information tools for analysis of the situation currently available. The study attempts to illuminate heretofore unmined and unavailable areas of information development needed for complete analysis of the impact of the food production system on quality of life in the region.

The Central Appalachian Assessment: Opportunities for Ecological Restoration

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Landscape-level analysis utilizing spatial data layers and GIS software may provide Appalachia opportunities for non-industrial economic growth by identifying, protecting and restoring critical forest habitat. Biological diversity in Central Appalachia is on the decline, yet overall forest cover is increasing. In response, ARC's three-phased Central Appalachian Assessment provides a platform for implementing wildlands restoration and rural economic revitalization in Appalachia. Portions of Phase One are presented here--specifically the assessment study area, ecoregions, rare, threatened and endangered species locations within the study area, and Roadless Opportunity Areas on the Monongahela National Forest.

EMAP's Approach to Managing Regional Data

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Assessing the overall environmental health of a region invariably means using databases from various organizations. The traditional choice faced by data managers of projects on the scale of the Mid-Atlantic Integrated Assessment (MAIA) is whether to try to rigidly centralize, which is time-consuming, expensive, and ultimately wasteful for one-time projects, or to use existing decentralized databases with all their problems of disparate formats. The Environmental Monitoring and Assessment Program (EMAP) is using a hybrid approach that incorporates desirable features of both options and that can live on at reduced scale after the original, larger project finishes. The two cornerstones to EMAP's approach are (1) that original data are best managed, described, and maintained by the organizations that collect them; and (2) that the closer these organizations can move toward common standards, directories, and descriptions for their separate databases, the easier it will be to integrate these data. EMAP uses four tools: (1) an Inventory of Environmental Monitoring Programs, which contains information about current data-collecting activities; (2) a Data Directory, which describes data sets of potential interest and points to the locations of supplementary non-EMAP data and metadata; (3) a web site (*http://www.epa.gov/emap*), which contains the Directory plus EMAP's data and metadata; and (4) "analytical" databases, small-but-centralized comprehensive databases on restricted subjects that allow all researchers to access data that are fully consistent across an entire region. These principles and tools comprise a hybrid approach that meets modern challenges of data management and that can be sustained by the home regions.

Designing a Spatially Balanced, Random Site Selection Process for a Regional Scale Stream Survey in the Mid-Atlantic - The EMAP Pilot Study

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Sample surveys have been used with great effectiveness in a variety of fields to describe the characteristics of populations that are too numerous to census efficiently. Best known are surveys associated with political polls (e.g. Gallup polls). Although sample surveys have long been used in a variety of arenas, their use for characterizing water resources has been limited. In 1993, the U.S. EPA, as part of the Environmental Monitoring and Assessment Program (EMAP), initiated a sample survey of streams in the mid-Atlantic. One of the major objectives of the survey was to quantify ecological condition in wadeable streams across the region. To accomplish this goal, 615 stream sites were selected using a randomized, systematic sampling design. The design utilized the digitized stream network taken from 1:100,000 scale USGS topographic maps as the sample frame. Using a GIS, 1st through 3rd order (wadeable) stream segments in the frame were randomly laid out in a line and sampled at fixed intervals after a random start. A variable probability approach was used so that roughly equal numbers of 1st, 2nd, and 3rd order stream sites would appear in the sample. The sample design allows inference to the status of the entire 230,000 km of wadeable stream length in the mid-Atlantic study area from the sample data. Samples were successfully collected from 509 sites representing 80% or 185,000 km of the mapped stream length. The remaining 20% of the mapped length was unsampleable due to access denials (7%), inaccessibility (4%), lack of a stream channel (4%), or a dry stream bed (5%).

Summary of Ecological Data Collected during EMAP, REMAP, and TIME Stream Surveys in the Mid-Atlantic Region

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The surface water component of the USEPA's Environmental Monitoring and Assessment Program (EMAP) began stream pilot activities in the mid-Appalachian region in 1992. EMAP research was conducted along with the Temporally Integrated Monitoring of Ecosystems (TIME) and EPA Region 3 Regional Environmental Monitoring and Assessment Program (REMAP) programs. The ecological data that were collected during these studies were: biological response indicators (fish, macroinvertebrate and periphyton assemblages), functional system indicators (sediment metabolism and respiration), chemical indicators (major cations and anions, acid-base chemistry, nutrients, total iron and manganese, turbidity and color), physical habitat assessment metrics and RBP Habitat data, contaminant indicators (fish tissue and sediment toxicity) and research protocols (fish biomarkers). Over the first 3 years of the study, 615 wadeable stream sites were randomly selected for study throughout EPA Region III (DE, MD, VA, WV, PA) and the Catskill Mts. of New York. Samples were collected from 509 of these randomly chosen sites plus 68 hand-picked reference/test sites during an index period from April to July. These sites were sampled by crews of USEPA, U.S Fish and Wildlife Service, state and U.S. EPA contract personnel in each of the operational units of the EMAP, REMAP, and TIME projects. In 1996 two index periods were sampled, the spring low flow index period (April - July) and a summer low flow period (July - September). In 1997 and 1998, the EMAP Surface Water Program extended the geographical coverage to the Mid-Atlantic Integrated Assessment (MAIA) study area, added an additional class of streams to be sampled (Large Rivers) and changed the index period to summer low flow, July - September. The MAIA study consisted of approximately 400 sites spread from southern New York to northern North Carolina. More sites were located in the Piedmont and Coastal Plain Ecoregions than were sampled in the previous EMAP and REMAP programs.

Riparian Forest Restoration: Stream Geomorphology and Ecological Implications

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The restoration of riparian or streamside forests has become a major focus of watershed initiatives throughout the mid-Atlantic region of the United States. Many people view these riparian buffers as management tools to filter pollutants from adjacent sources of sediments and nutrients. However, we view riparian forests as integral components of the landscape that regulate the structure and function of stream ecosystems. We are currently conducting two integrated, multi-disciplinary research projects to evaluate the effects of riparian forest restoration on aquatic ecosystems. The first, part of the EPA/NSF Water and Watersheds Program, is based on the hypothesis that headwater riparian forests are primary regulators of stream geomorphology which in turn influences the structure and function of stream ecosystems. The second, part of the EPA-ORD Ecological Restoration Grant Program, focuses on how catchment conditions (i.e., urbanization) affect the success of riparian forest restoration efforts designed to improve water quality and stream health. Combined, these projects involve extensive geomorphic and ecological measurements on study reaches with forest, meadow, open, and restored riparian zones in more than 30 1st through 4th order streams in southeastern Pennsylvania and northeastern Maryland. We will present the geomorphologic measurements that suggest that forested streams are significantly different from streams bordered by meadows or mowed grasses. In addition, we will present preliminary data that suggests that: 1) this geomorphic difference influences aquatic ecosystem structure and function, and 2) the nature of riparian forests' beneficial influence on stream ecosystems is affected by catchment conditions.

Modeling Land-Use Change in MAIA

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The EPA Office of Research and Development (ORD) is addressing the question, "Where will projected land-use change most threaten ecological resources in the mid-Atlantic region?" Research is progressing within a multiple-scale framework to identify 1) county aggregations and 2) specific watersheds where projected growth and land-use conversion pose significant threats to sensitive ecological resources. A combination of region-wide modeling techniques is currently being pursued in-house and with the Departments of Agriculture and Interior. Synthesis of these results will identify multiple-county aggregations most likely to undergo significant land-use change. When overlaid with large-scale ecological resources of concern, these subregions will illustrate community risk management priorities for EPA Regions II, III, and IV. They will also provide the focus for more intensive research, serving as test areas for the application and integration of higher-resolution, spatially explicit models developed within ORD, EPA Program Offices, and the academic community. Collaborative application of these models under selected economic and policy scenarios will lead to local development profiles across a range of resolutions and certainty. ORD will use the detailed development profiles that emerge to drive exposure and effects models, arriving at ecological vulnerability profiles at the eight-digit watershed scale. Vulnerability profiles will include ecological resources directly displaced by land-use conversion, and those indirectly impacted by increased quantity and toxicity of runoff and air pollution.

Patterns of Breeding Bird Diversity and Landscapes in the United States Mid-Atlantic Region

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Changes in landscape composition and pattern have significant consequences for plants, animals, and entire biotic communities, primarily through alteration of the amount and spatial pattern of suitable habitat. Changes in suitable habitat influence landscape-level processes of plant and animal metapopulations, including immigration, emigration, and population sizes; these in turn influence species' vulnerabilities to (probabilities of) extinction. Broad-scale changes in landscape patterns across regions, including decline and fragmentation of natural land cover types, and increases in agricultural lands and urban environments, have resulted in declines in biological diversity, terrestrial productivity, water quality, and certain ecological services, such as resistance and resilience to catastrophic flooding.

Taking advantage of a new set of continuous landscape data of relatively fine scale (30 meters), and a 30-year database on breeding bird abundance and diversity, we evaluated relationships between breeding bird diversity and metrics of landscape pattern across the United States Mid-Atlantic Region. This paper reports results of this study and discusses the results within the context of regional-scale, landscape analysis.

Notice: *The U.S. Environmental Protection Agency, through its Office of Research and Development funded this research and approved the abstract as the basis for an oral presentation. The actual presentation has not been peer reviewed by EPA. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.*

Restored Riparian Buffers as Tools for Ecosystem Restoration in the MAIA; Processes, Endpoints, and Measures of Success for Water, Soil, Flora, and Fauna

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Riparian buffer restorations are used as management tools to produce favorable water quality impacts and the basis for riparian buffers as an instrument of water quality restoration rests on a relatively firm foundation. However, the extent to which buffers can restore riparian ecosystems; their functionality and species composition, are essentially unknown. In light of the foregoing, two broad areas of research are indicated. First, data are needed to document the relative effectiveness of riparian buffers that differ according to width, length, and plant species composition. These questions, of optimizing buffer dimension and species composition for functionality, are of central importance even when attenuation of nutrient and sediment loads alone are considered. Second, where ecosystem restoration is the goal, effects to in-stream and terrestrial riparian biota need to be considered. Relatedly, the effects of the restoration on the landscape need to be considered. Particularly, at what rate do the effects of the riparian buffer on in-stream water quality, biota, and habitat diminish downstream from restored sites? Answers to these important questions are needed, for streams and watersheds of different size and for areas of differing soil type within watersheds. USEPA-NRMRL has initiated a research project that will document the potential for buffers to restore riparian ecosystems; focusing on water quality effects but also, importantly, documenting effects on biota; particularly periphyton. The ultimate goal of research projects developed under this paradigm of ecosystem restoration is to develop data that are needed to implement riparian buffer restorations in the MAIA and elsewhere.

Terrestrial and Streamside Salamander Monitoring at Shenandoah National Park

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In response to concerns about widespread amphibian declines and the need to evaluate and validate monitoring techniques for amphibians, a study testing amphibian monitoring techniques was initiated in the spring of 1998 in Shenandaoh National Park. Fifteen salamander and ten anuran species are found in Shenandoah National Park, but testing focuses on salamanders because they are widespread and abundant throughout the Park. The goals of the program are to 1) evaluate bias and efficiency in several sampling methods for salamanders, and 2) assess spatial and temporal variation in salamander populations in relation to environmental variables. This work is conducted under the auspices of DISPro (Demonstration Intensive Site Project), an interagency effort of the EPA and NPS.

To evaluate bias and efficiency in sampling, research was conducted using a variety of population indexes and visibility-adjusted population estimation procedures. Population size of terrestrial salamanders was estimated from mark-recapture and area-constrained searches on the forest floor and under natural and artificial cover objects during the day and on wet nights. For stream and streamside salamanders, four monitoring methods (leaf litter bags, shoreline transect searches, 1 m^2 quadrat searches, and electroshocking) were used throughout the Park. To evaluate associations of salamanders and environmental variables, vegetation, soil pH and moisture, water quality, and other variables were measured at sampling sites. In conjunction with pilot data from other salamander monitoring efforts at the USGS Patuxent Wildlife Research Center and other sites, the monitoring results will be used to help establish park-wide long-term standardized monitoring programs for salamander species.

Maryland Biological Stream Survey: Application of Probability-Based Sampling to Watershed Assessment and Aquatic Resource Management

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During 1995-97, the Maryland Department of Natural Resources conducted a statewide survey of 1st through 3rd order non-tidal streams to assess ecological conditions. The goals of the survey were to characterize the current status of Maryland streams, provide a baseline inventory for future trend analysis, identify relationships between stressors and ecological condition, and aid in the targeting of restorations and protection activities. A probability-based, lattice sampling design stratified by river basin and stream order was used to select the 955 segments sampled. At each 75 m segment, fish, benthic macroinvertebrates, herpetofauna, water quality, and physical habitat were evaluated. Cluster analysis was performed on biological data to define natural community stratification. Non-biological, *a priori* criteria were applied to the dataset to establish reference conditions, and Indices of biotic integrity (IBIs) were tested and validated for fish and benthos and applied to identify healthy and degraded streams. On a statewide basis, fish assemblages indicate that 20%, 26%, 15% and 14% of stream miles were in good, fair, poor and very poor condition, respectively (25% of streams were not rated using the fish IBI because of small watershed size (<300 acres). Overall, benthic IBIs indicated a higher degree of impairment, with 11% good, 38% fair, 26% poor, and 25% of stream miles in very poor condition. Using an approach similar to that used for the fish and benthic IBIs, a provisional index of habitat quality was constructed and applied on a statewide scale. In addition to characterizations using ecological indices, quantitative estimates of fish populations were made. Approximately 61 million fish are found in Maryland streams, with just two species, blacknose dace and mottled sculpin, comprising 33% of the total. In contrast, 7 native stream species had populations less than 5000 individuals. Based on probable species distributions, brook trout and American eel, once dominant features of Maryland streams, have declined markedly due to widespread habitat loss. Conversely, few watersheds in Maryland did not contain introduced species. Analysis of landscape features and IBIs revealed a pronounced decline in fish communities in acid-sensitive watersheds as well as relationships between land cover, imperviousness, and IBIs. Using MBSS findings, more than 100 areas of the state have been targeted for protection and enhancement because they represent high quality or reference conditions. In addition, results of the survey were used as part of the Unified Watershed Assessment in support of the Clean Water Action Plan.

Providing Customized GIS Resources for Watershed-Based Citizen/Stakeholder Groups

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The Canaan Valley Institute (CVI) is a non-profit, non-advocacy organization serving communities of the Mid-Atlantic Highlands region. CVI works to aid communities in implementing locally-determined solutions to problems that threaten the economic or environmental resources of their watershed. The Institute is committed to improving the quality of life for the residents of the Mid-Atlantic Highlands by offering assistance to eligible groups interested in enhancing the economic and environmental sustainability of their communities. The assistance includes but is not limited to training workshops, technical expertise, monetary grants, and informational resources.

The Natural Resource Analysis Center (NRAC) at West Virginia University conducts a wide range of research activities centered in GIS, remote sensing, and natural resource policy and management. Current research and project areas include GIS-based decision support systems, application of spatial methods in economic policy analyses, vegetation and land cover mapping, watershed planning and restoration, wildlife habitat and distribution modeling, internet-based application development, and GIS software training.

Together, CVI and the NRAC are working to develop a set of customized GIS resources for use by watershed-based citizen and/or stakeholder groups across the Mid-Atlantic Highlands region. These GIS resources are being developed using a variety of spatial, non-spatial, and web-based products and formats, and are designed to meet varying levels of need and expertise by the watershed groups.

Introduction to the USEPA's Multimedia Integrated Modeling System

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The EPA's Office of Research and Development, under the initiative of the National Exposure Research Laboratory, is embarking on a long-term project to develop a Multimedia Integrated Modeling System (MIMS). The system will have capabilities to represent the transport and fate of nutrients and chemical stressors over multiple scales. MIMS will be designed to improve the environmental management community's ability to evaluate the impact of air quality and watershed management practices on stream and estuarine conditions. The system will provide a computer-based problem solving environment for testing our understanding of multimedia (atmosphere, land, water) environmental problems, such as the movement of chemicals through the hydrologic cycle, or the response of aquatic ecological systems to land-use change, with initial emphasis on the fish health endpoint. The design will attempt to combine the state-of-the art in computer science, system design, and numerical analysis (i.e. object oriented analysis and design, parallel processing, advanced numerical libraries including analytic elements) with the latest advancements in process level science (process chemistry, hydrology, atmospheric and ecological science). The problem solving environment will embrace the watershed/airshed approach to environmental management, and build upon the latest technologies for environmental monitoring and geographic representation. The MIMS team will promote a common and open development framework for the university and government modeling communities, and be open to partnerships with the private sectors when appropriate.

Overview of the Terrestrial Theme Session

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I will present an overview of the Terrestial Theme Session. Many of the papers presented in this session stem from the close cooperation between the Environmental Protection Agency and the Forest Service. These two agencies, in collaboration with other agencies and Universities, have intensively studied the Mid-Atlantic, as part of the Mid-Atlantic Integrated Assessment (MAIA). The main impetus for this effort was the desire to produce a "State of the Forests" report for the MAIA region. The Report is being completed in phases. It is being done in a way that tests important components of the National Environmental Monitoring Initiative (NEMI), which is a framework developed in 1997 by a host of federal agencies outlining how agencies need to work together to improve the quality of their environmental assessements. The main theme of the NEMI framework is that assessments should be done across agency, across scale and across media. The papers in this session are efforts to show progress in the use of this important framework for making truly integrated assessments.

Assessment Framework for Mid-Atlantic Coastal Plain Streams Using Benthic Macroinvertebrates

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A collaborative study was completed among 6 states along the Mid-Atlantic seaboard of the U.S. A consistent approach was developed for collecting and interpreting macroinvertebrate data for low gradient nontidal coastal streams. The study had 3 objectives: (1) evaluate the validity of aggregating reference site data into a single region (i.e., "Bioregion"), (2) select biological metrics that best discriminate reference sites from sites impaired by habitat disturbance and organic pollution, and (3) develop an index that combines these metrics into an index of biological quality. Macroinvertebrate, physical habitat, and water quality data were collected in 106 streams during the Fall of 1995; 55 reference, 34 habitat stressed, and 17 water quality stressed sites were sampled. The classification of reference sites divided the coastal plain into 3 Bioregions separated north and south by the Chesapeake Bay and separated east and west by physiographic region (i.e., Ecoregion). Five metrics were found to be effective at discriminating impairment including the total number of taxa, number of EPT taxa, %Ephermeroptera abundance, the Hilsenhoff Biotic Index, and % clinger. An aggregated index, the Coastal Plain Macroinvertebrate Index (CPMI), developed using these metrics accurately assessed impaired sites 86% of the time. Reference sites in Bioregion 63S (the southern portion of Ecoregion 63) were highly variable and affected the discriminatory ability of the CPMI. This variability was likely due to the abundance of naturally acidic waters in the southern coastal plain and lack of long-term pH data.

The CPMI was equally accurate at assigning habitat and water quality impairment indicating a similar degree of ecological impact from these 2 stressors. Guidance is provided in applying the CPMI to other macroinvertebrate data sets in the region.

Assessing the Impacts of Forests on Human Welfare: Preliminary Results from the MAIA Forest Socioeconomic Assessment

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The overall goal for socioeconomic component of the MAIA forest assessment is to develop systems for understanding and monitoring the relationship between changes in forest ecosystems and human well-being and quality of life in the MAIA region. During meetings with stakeholders in the region, 22 socioeconomic assessment questions were identified covering land use, resource (market and non-market) use, population demographics, investments in forest management, and forest policies. In the first phase of this effort, we are concentrating on assessing trends in forest resource use over the past two decades. In this paper, we present preliminary results from a subset of the 22 assessment questions. First, we present results of the analysis of changes in the distribution of human population and economic activities associated with forest resource dependent industries and tourism in the MAIA. Second, trends in wood products employment and income between 1975-1995 are used to examine the economic contributions of the forest based manufacturing sector in the Mid-Atlantic region. Finally, we examine the supplies of and demands for major types of forest recreation settings and activities within the MAIA region. We discuss the implications of these results for forest management and policy and suggest research for the second phase of the MAIA forest ecosystems assessment.

Using MAIA Information for Management Decisions and Informing the Nontechnical Public

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The inherent complexity of even the best scientific data often detracts from its usefulness as a tool for selecting and championing policy. In the courtroom, meeting room, the Congress or the voting booth, the messages carried by scientific evidence are found effective only in proportion to the clear simplicity of how that message is conveyed.

Unfortunately, the cornerstone evidence used by the EPA to pursue environmental protection is often terribly complex. The need to interpret our intricate monitoring and research data into displays useful to the public debate has grown to a point where we need to find better ways to help the non-scientist better understand the messages the data can tell.

There are several messages which data-based information supports:

- documenting and illustrating EPA's messages;
- using environmental indicators to measure pro gress;
- selection of environmental priorities;
- helping the assessment of state PPA/PPG proposals;
- describing the impact of environmental action or inaction on people and/or living resources;
- provide data, information and tools to the public and communities so they can evaluate environmental information for their "neighborhoods" and make knowledgeable decisions.

The need for clearly expressed and easily understandable information expands further when one considers the growing variety of media choices available for carrying our message. Written press releases are now only the tip of the iceberg that includes TV, targeted video productions, web sites and related Internet linkages.

This discussion will offer some guidelines for visually presenting technical information to managerial and to non-technical audiences with some examples of each.

A Report on the Condition of the Mid-Atlantic Estuaries

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For environmental management programs to be effective, decision-makers need to have an understanding of current environmental conditions as well as information on trends or changes that may be occurring over time. The report, Condition of Mid-Atlantic Estuaries, summarizes our current understanding of the ecological condition of estuaries in the Mid-Atlantic. Sources of information included program reports and databases produced by National Estuary Programs, Chesapeake Bay Program, state monitoring programs in Delaware, Maryland, and Virginia, and federal programs such as NOAA National Status & Trends Program, NOAA National Shellfish Register, USFWS National Wetlands Inventory, and EPA's Environmental Monitoring and Assessment Program. Information is presented on water quality (e.g., nutrient levels and dissolved oxygen concentrations), sediment contamination, and the condition of wetlands and living resources (e.g., benthos, fish, shellfish, and waterfowl). This information has been analyzed and summarized in a "report card" on ecological condition.

Major findings regarding specific problems include: the shellfish industry is one of the most impacted industries of the Mid-Atlantic states and is also one of the most severely threatened. The decline in oyster harvests has been precipitous, and is related to disease, overfishing, and pollution. The Delaware Estuary is highly impacted by lingering toxic contaminants associated with urbanization in the estuarine watershed and industrialization along the lower section of the Delaware River. Chesapeake Bay is the most hypoxic (very low dissolved oxygen concentrations) of estuaries in the region. The low levels of dissolved oxygen are primarily a result of nutrient overenrichment. The Delmarva coastal bays are moderately enriched, particularly in Delaware, largely from agricultural sources. Eutrophication is increasingly noticeable in dead end canals along developed shorelines. The coastal waters presently exhibit low levels of nutrients and chlorophyll; however, evidence suggests that these levels may be rising, indicating a potential for future environmental problems.

The Mid-Atlantic estuaries are being impacted to varying degrees. They are at risk and in need of active management to restore and maintain environmental quality and sustainable resources. The states, in conjunction with EPA through the Chesapeake Bay Program and the National Estuary Programs, have instituted environmental management programs to address these environmental concerns. The results of these environmental programs are becoming evident.

The Baltimore Ecosystem Study: A Long Term Ecological Study of a Metropolitan Area

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Metropolitan areas are complex ecosystems that have hardly been examined from a rigorous ecological perspective. To develop approaches and methodologies to address this problem, the National Science Foundation funded for the first time two urban Long Term Ecological Research (LTER) Projects in 1997. The Baltimore Ecosystem Study (BES) was one of the two proposals selected for the entire U.S.A. This new and exciting LTER project will be funded for six years and if successful will be funded for additional six year periods so that long term data will be collected. As part of the research program, we will employ descriptive, historical and experimental analyses. We will characterize and monitor vegetation, soils, hydrologic and atmospheric processes, and socioeconomic dynamics. We will produce high resolution, whole-watershed and whole-city estimates of ecological and socioeconomic fluxes, as well as simulation models capable of depicting the interactive effects of land use, habitat and social change on ecological functions. Data from historical records and sediment pollen cores will allow us to test hypotheses about how social and ecological factors interact to affect how these functions have changed in the past and how they might change in the future. Both educational and technological transfer programs will be developed to ensure that data and knowledge gained from BES will be made available to the general public and government agencies.

An Assessment of Contaminant Trends and Data Gaps for Terrestrial Vertebrates Residing within Atlantic Coast Estuaries

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The Biomonitoring of Environmental Status and Trends (BEST) program of the Department of the Interior is focused to identify and understand effects of contaminant stressors on biological resources under their stewardship. One BEST program activity involves evaluation of retrospective data to assess and predict the condition of biota in Atlantic coast estuaries. A "Contaminant Exposure and Effects--Terrestrial Vertebrates" database (CEE-TV) has been compiled through computerized literature searches of AGRICOLA, Aquatic Sciences and Fisheries Abstracts, BIOSIS, Fish and Wildlife Reviews, and TOXLINE, review of existing databases (e.g., US EPA Ecological Incident Information System, USGS Diagnostic and Epizootic Databases), and solicitation of unpublished reports from conservation agencies, private groups, and universities. Summary information has been entered into the CEE-TV database, including species, collection date (1965-present), site coordinates, sample matrix, contaminant concentrations, biomarker and bioindicator responses, and reference source, utilizing a 96-field dBase format. Currently, the CEE-TV database contains 3650 geo-referenced records representing 189 vertebrate species and >150,000 individuals residing in estuaries from Maine through Florida. This relational database can be directly queried, imported into the Geographic Information System to examine spatial tendencies, and used to identify "hot-spots", generate hypotheses, and focus ecotoxicological assessments. An overview of temporal, phylogenetic, and geographic contaminant exposure and effects information, trends, and data gaps will be presented for terrestrial vertebrates residing in estuaries in the mid-Atlantic region of the United States.

The Regional Vulnerability Assessment Program

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Regional vulnerability assessment (ReVA) can be defined as the assessment of the likelihood that stressors to ecosystems in a defined area will cause ecological processes and functions to vary beyond the range of natural variability, such that subsequent adverse effects could reduce that ecosystem's ability to provide the ecological goods and services that the public has come to expect and desire. It is comparative, in that it seeks to simultaneously include multiple stressors, multiple receptors, and multiple scales. The goal of ORD's ReVA research is to provide to decision-makers and stakeholders with a process to do an assessment of the current and anticipated regional ecosystem vulnerabilities, based on observed and predicted changes in exposures acting singly, and in combination. Accomplishing this goal will enable stakeholders to target limited resources at specific areas and problems where intervention, restoration, or protection is most critical and/or cost effective.

The Mid-Atlantic Region has been selected as the pilot location to develop, test, and document scientific approaches to ReVA. The initial focus of work has been to identify and characterize stressors within the region, and a preliminary product, *The Mid-Atlantic Stressor Profile Atlas*, will be released soon. The *Atlas* presents maps depicting acid deposition, coal mining, population growth, landscape patterns, agricultural nitrogen enrichment, tropospheric ozone concentrations, pesticide use, soil erosion, and UV-B irradiance. Future work will concentrate on 1) refining stressor profiles in terms of accuracy and inclusiveness, then doing future predictions; 2) characterizing receptors and developing exposure profiles for current and future scenarios; and 3) completing a comparative ecological risk assessment for the region by 2001.

Using Forest Inventory and Health Monitoring Data to Assess the Diversity, Productivity and Health of Trees in the Mid-Atlantic Region

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The Forest Inventory and Analysis (FIA) and Forest Health Monitoring (FHM) programs of the USDA Forest Service manage an extensive network of field plots that are the best available sources of forest tree measurements in the mid-Atlantic region. This study utilized FIA data collected from 22,382 one-fifth acre plots to estimate the regional abundance and distribution of living trees and dead trees by species and size. FHM data collected from 193 one-sixth acre plots were also used to provide information pertaining to annual changes in health of trees as evident from crown conditions and stem/root damage. The collective analyses of these data were used to assess species diversity, productivity, regeneration, mortality, removals and current health of trees throughout the forest. Statistical results were summarized to depict stand- and landscape-level attributes by state and ecological subsection. Corresponding geo-referenced data sets were also created for eventual integration with information from other assessments. Analytical findings can be used by land managers to help: 1) evaluate the current status of forest health, 2) identify forest resource issues, 3) plan forest management goals, and 4) integrate other sources of information about natural resources in the mid-Atlantic region.

The Mid-Atlantic Highlands Assessment: Ecological Condition of Small Streams

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The Mid-Atlantic Highlands Assessment (MAHA) is a product of the Environmental Monitoring and Assessment Program (EMAP) surface waters component. Its goals are to describe the ecological condition of first though third order streams in the Highlands using biological assemblage data, to describe the relative risk to streams from major stressors in the region, and to "diagnose," through associations, the likely causes of ecological impairment. In 1993 and 1994, just over 500 stream reaches, selected through a probability design, were sampled in the late spring. Each stream was sampled to describe its fish, benthic invertebrate and periphyton assemblages, fish tissue contamination, instream chemistry, and instream and riparian habitat measures. Using a fish Index of Biotic Integrity (IBI), the MAHA report finds that half (51%) of stream miles in the Highlands are in poor condition with respect to fish assemblages. The richness of sensitive invertebrate taxa (*Ephemeroptera*, *Plecoptera* and *Trichoptera*, or EPT) suggests that most stream miles are in good (53%) or marginal (30%) condition. The most common stressors are introduced fish species (34% of stream miles have non-native fish present), riparian habitat disturbance (24% of stream miles poor condition), instream habitat disturbance (17% in poor condition), mine drainage (14% of stream miles have mine drainage impacts), acidic deposition (10% affected), nutrient enrichment (5%).

Analysis of Forest Health in the MAIA Region

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The Forest Health Monitoring (FHM) program is evaluating the health of the forests in the MAIA region, by developing a set of assessment issues for the forest, based on the ecological criteria and indicators detailed in Santiago Declaration. This report outlines the process for evaluation of forest health, and addresses two of the major criteria, productivity and vitality. To address these issues, we evaluated some of the major forest stressors and the spatial and temporal patterns in the condition of the forests. Spatial and temporal trends in forest condition were based on Forest Health Monitoring plot and survey data collected in 1991-1997, and analyzed by ecoregion sections. We found that the northern half of the MAIA is in a high wet deposition area for nitrate, sulfate, and hydrogen ion based on 1979-1995 NADP data. Lichen species diversity was low in these areas. Ozone exposure is high in MAIA, as is ozone injury to bioindicator species. Change in tree volume and carbon sequestration was low, and tree mortality high in one ecosection in MAIA. Transparency of tree crowns is increasing in some ecosections in MAIA, and damage to trees from multiple causes is increasing in some ecosections. The mortality risk to trees from gypsy moth is high throughout the MAIA region.

Using Resource Economics to Predict Land Use in the Mid-Atlantic Region

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Demands for forest, farm, and developed land are evolving in the mid-Atlantic region. The demand for land in developed uses, as well as demands for various forest and farm products are changing in response to population growth, demographic shifts, and market forces. As demand factors change so do relative land values. Land area in future forest, farm, and developed uses may shift as landowners re-evaluate relative net benefits from land use alternatives.

This study examines the effects of various land demand and supply factors on the determination of land use patterns in the mid-Atlantic region. Driving variables include costs and benefits from various uses, per-capita income, farmland owner age, and measures of land quality. Model parameters are estimated using a generalized multinomial logit procedure. Results from the study are used to estimate proportions of area by land use category (forest, pasture, crop, and urban) on a county by county basis. Simulated landscapes under hypothetical future economic conditions are prepared and illustrated using geographic information system (GIS) techniques.

Forest-Stream Interactions within the Mid-Atlantic Region

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Agricultural and urban land use activities have affected stream ecosystems throughout the Mid-Atlantic region. However, over 70% of the Mid-Atlantic region is forested. A study was conducted to investigate the effects of management practices on forested stream ecosystems throughout the Mid-Atlantic region. The study consisted of two phases: Phase 1 was a literature synthesis of information available on the effects of forest management practices on stream hydrology, erosion and sedimentation, riparian habitat alteration, chemical addition, and change in biotic diversity in the Mid-Atlantic region. In Phase 2, data from mid-Atlantic streams were analyzed to assess the effects of forest land use on stream quality at the regional scale.

Typically, it is the larger order streams in which monitoring and assessment occurs - 3rd order or higher streams. The impacts of forest management practices, particularly hydrologic modifications and riparian buffer zone alteration, occur predominantly in first and second order streams with cumulative impacts translating to higher order streams. Nutrient increases from forest management practices are generally small, but pesticide additions are more prevalent. A series of conceptual models have been developed to depict the interaction among forested land use and stream quality in the Mid-Atlantic. These conceptual models will be presented to explain the regional estimates of stream quality throughout the Mid-Atlantic Highlands.

Change in the Acid-Base Status of Streams Associated with Forested Mountain Watersheds in the Mid-Appalachian Region

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The mid-Appalachian region is one of the areas of the United States most affected by acidic deposition. Many of the upland streams in the mid-Appalachian region are especially susceptible to acidification due to high rates of acidic deposition, the presence of watersheds with base-poor bedrock, and the delayed-response properties of regional soils. The Shenandoah Watershed Study and the Virginia Trout Stream Sensitivity Study have provided a quarterly record of stream water composition for 64 streams associated with forested mountain watersheds in the western Virginia region. Classification by watershed bedrock type explains variation in current acid-base status of the sampled streams. Among streams in the Blue Ridge Mountain province, the median acid-neutralization capacity is 3.4 μeq/L for streams associated with siliciclastic bedrock, 59.8 μeq/L for streams associated with granitic bedrock, and 161.3 μeq/L for streams associated with basaltic bedrock. Among streams in the Ridge and Valley province, the median acid-neutralization capacity is 0.6 μeq/L for streams associated with siliciclastic bedrock, 23.6 μeq/L for streams associated with minor carbonate bedrock, and 167 μeq/L for streams associated with carbonate bedrock. More than 50% of the streams in western Virginia that support reproducing populations of the native brook trout (*salvelinus fontinalis*) drain siliciclastic watersheds. The acid-base status of these streams reflects an unfavorable balance between sulfate from atmospheric sources and base cations from watershed sources. An analysis of change in the acid-base status of these streams must account for change in atmospheric deposition and for variation related to discharge and forest disturbance.